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EXTRACT
FROM THE
ANNUAL REPORT OF THE SECRETARY OF WAR.

The reports of the officers employed under the appropriations made for explorations and surveys to ascertain the most practicable and economical route for a railroad from the Mississippi river to the Pacific ocean were submitted to Congress on the 27th of February last, with a report from this department, giving a general sketch of the country over which they extended, a recapitulation of their results, and a comparison of their distinguishing characteristics; from which it was concluded that of the routes examined, the most practicable and economical was that of the thirty-second parallel. A report is herewith submitted from the officer in this department charged with the revision of the work of the several parties, and I refer to it for additional information derived from materials collected, on a further examination of them by himself, and the several officers who made the particular surveys, as well as for the results of explorations carried on during the past year.

When the report was made, in February last, many of the maps, drawings, and scientific papers, intended to form part of the report, and which could only be prepared after an elaborate examination of the materials collected, had not been completed for want of time, and it became necessary to substitute hastily prepared drawings and preliminary reports. This was particularly the case with regard to the work on the route of the thirty-fifth parallel. A minute examination of the material collected in that survey has resulted in showing the route more practicable than it was at first represented to be, and in reducing to nearly one-half the original estimates of the officer in charge of the survey, which indeed seemed, when they were submitted, to be extravagant, and were noted in the report from this department as probably excessive.

Another feature of interest developed in the course of the further examination of the work on the route of the thirty-second parallel is, that the Colorado desert, which is traversed by the route for a distance of 133 miles, and which, in the report referred to, was noted as consisting of a soil that needed only water to render it highly productive, is, in fact, the delta of the Colorado river, and, according to barometric levels, is so much lower than that stream as to be easily irrigated from it. Thus there is every reason to believe 4,500 square miles of soil of

great fertility, of which nearly one-half is in our territory, may be brought into cultivation in one unbroken tract along the route.

Under the appropriation made at the last session for the continuation of these surveys and other purposes, three parties have been in the field during the past season.

One of these was directed to make examinations connected with the routes of the 32d and 35th parallels. This survey has greatly improved the aspect of the former route by changing the line for nearly half the distance between the Rio Grande and the Pimas villages on the Gila river from barren ground to cultivable valleys, and entirely avoiding a *jornada* of eighty miles, which occurs in that section; also by the discovery of an eminently practicable route through cultivable country from the plains of Los Angeles, along the coast and through the Salinas valley, to San Francisco. The connexion originally proposed between these points was by way of the valley of San Joaquin and the Great Basin.

The attention of this party was also directed to an examination into the practicability of procuring water along certain parts of the route where it is now deficient. The report shows that it may be obtained by common wells at distances of about twenty miles.

From the result of this exploration, moreover, it appears practicable to obtain, at a small expense, a good wagon road, supplied with water by common wells, from the Rio Grande down the San Pedro and Gila and across the Colorado desert. Such a road would be of great advantage in military operations, would facilitate the transportation of the mail across that country, and relieve emigrants pursuing that route from much of the difficulty and suffering which they now encounter.

A second party was charged with the duty of testing the practicability of procuring water by artesian wells on the Llano Estacado, an arid plain which has been heretofore described as a desert. The experiment has so far demonstrated its practicability as to leave little doubt of its final success; it will be continued, however, until the problem shall have been fully solved.

The examinations into the feasibility of causing subterranean streams to flow upon the surface from artesian wells, though undertaken in connexion with the practicability of a railroad, if they should prove entirely successful, will have a value beyond their connexion with that object in the reclamation of a region which is now a waste, and its adaptation to the pastoral, and, perhaps, the agricultural uses of man.

The third party was directed to conduct an exploration from the Sacramento to the Columbia river, with a view to ascertain the practicability of a route to connect the valleys of those rivers. The officer in charge has reported the successful completion of the duty, but has not given details. The same officer has been directed to make a reconnaissance of the Sierra Nevada in the vicinity of the head branches of Carson river.

The prosecution of instrumental surveys, accompanied by an investigation into many branches of physical science simultaneously over lines of such length, and embracing such an extent of latitude, is a work of greater magnitude than any of the kind hitherto undertaken

by any nation; and its results have not only proved commensurate with the amount of work done, but possess a value peculiar to the scale on which it has been conducted, as affording a basis for the determination of some questions of science which no number of smaller and detached explorations could have furnished. Should means be granted pursuant to the estimate in the report referred to, for continuing these explorations, I have every confidence that the expenditure will be well repaid by these contributions to our knowledge of the interior of the country.

The facts developed by these surveys, added to other information which we possess, suggest some considerations of great interest with regard to our territory on the Pacific. They exhibit it as a narrow slope of an average width of less than one hundred and fifty miles of cultivable land, skirting the ocean for a distance of one thousand miles; rich in those mineral productions which are tempting even beyond their value, and which would be most readily turned to the use of an invader; drained by two rivers of wide-spread branches, and with sea-ports lying so directly upon the ocean that a hostile fleet could commence an attack upon any one of them within a few hours after being descried from land; or, if fortified against attack, so few in number that comparatively few ships would suffice to blockade them.

This territory is not more remote from the principal European States than from those parts of our own country whence it would derive its military supplies, and some of those States have colonies and possessions on the Pacific which would greatly facilitate their operations against it. With these advantages, and those which the attacking force always has, of choice of time and place, an enemy possessing a considerable military marine could, with comparatively little cost to himself, subject us to enormous expenses, in giving to our Pacific frontier that protection which it is the duty of the general government to afford.

In the first years of a war with any great maritime power, the communication by sea could not be relied upon for the transportation of supplies from the Atlantic to the Pacific States. Our naval peace establishment would not furnish adequate convoys for the number of storeships which it would be necessary to employ, and storeships alone laden with supplies could not undertake a voyage of twenty thousand miles, passing numerous neutral ports, where an enemy's armed vessels, even of the smallest size, might lie in wait to intercept them.

The only line of communication, then, would be overland; and by this it would be impracticable, with any means heretofore used, to furnish the amount of supplies required for the defence of the Pacific frontier. At the present prices over the best part of this route the expense of land transportation alone for the annual supplies of provisions, clothing, camp equipage, and ammunition for such an army as it would be necessary to maintain there, would exceed \$20,000,000; and to maintain troops and carry on defensive operations under those circumstances, the expense per man would be six times greater than it is now: the land transportation of each field twelve-pounder, with a due supply of ammunition for one year, would cost \$2,500; of each 24-pounder and ammunition, \$9,000; and of a seacoast gun and ammu-

munition, \$12,000. The transportation of ammunition for a year for 1,000 seacoast guns would cost \$10,000,000. But the expense of transportation would be vastly increased by a war; and at the rates that were paid on the northern frontier during the last war with Great Britain, the above estimates would be trebled. The time required for the overland journey would be from four to six months. In point of fact, however, supplies for such an army could not be transported across the continent. On the arid and barren belts to be crossed, the limited quantities of water and grass would soon be exhausted by the numerous draught animals required for heavy trains, and over such distances forage could not be carried for their subsistence.

On the other hand, the enemy would send out his supplies at from one-seventh to one-twentieth the above rates, and in less time—perhaps in one-fourth the time—if he should obtain command of the isthmus routes.

Any reliance, therefore, upon furnishing that part of our frontier with means of defence from the Atlantic and interior States, after the commencement of hostilities, would be vain, and the next resource would be to accumulate there such amount of stores and supplies as would suffice during the continuance of the contest, or until we could obtain command of the sea. Assigning but a moderate limit to this period, the expense would yet be enormous. The fortifications, depots, and storehouses, would necessarily be on the largest scale, and the cost of placing supplies there for five years would amount to nearly one hundred millions of dollars.

In many respects, the cost during peace would be equivalent to that during war. The perishable character of many articles would render it perhaps impracticable to put provisions in depot for such a length of time; and in any case, there would be deterioration amounting to some millions of dollars per year.

These considerations, and others of a strictly military character, cause the department to examine with interest all projects promising the accomplishment of a railroad communication between the navigable waters of the Mississippi and those of the Pacific ocean. As military operations depend in a greater degree upon rapidity and certainty of movement than upon any other circumstance, the introduction of railway transportation has greatly improved the means of defending our Atlantic and inland frontiers; and to give us a sense of security from attack upon the most exposed portion of our territory, it is requisite that the facility of railroad transportation should be extended to the Pacific coast. Were such a road completed, our Pacific coast, instead of being further removed in time, and less accessible to us than to an enemy, would be brought within a few days of easy communication, and the cost of supplying an army there, instead of being many times greater to us than to him, would be about equal. We would be relieved of the necessity of accumulating large supplies on that coast, to waste, perhaps, through long years of peace; and we could feel entire confidence that, let war come when and with whom it may, before a hostile expedition could reach that exposed frontier, an ample force could be placed there to repel any attempt at invasion.

From the results of the surveys authorized by Congress, we derive at least the assurance that the work is practicable; and may dismiss the apprehensions which, previously, we could not but entertain as to the possibility of defending our Pacific territory through a long war with a powerful maritime enemy.

The judgment which may be formed as to the prospect of its completion, must control our future plans for the military defence of that frontier; and any plan for the purpose which should leave that consideration out of view, would be as imperfect as if it should disregard all those other resources with which commerce and art aid the operations of armies.

Whether we shall depend on private capital and enterprise alone for the early establishment of railroad communication, or shall promote its construction by such aid as the general government may constitutionally give; whether we shall rely on the continuance of peace until the increase of the population and resources of the Pacific States shall render them independent of aid from those of the Atlantic slope and Mississippi valley, or whether we shall adopt the extensive system of defence above referred to, are questions of public policy which belongs to Congress to decide.

Beyond the direct employment of such a road for military purposes, it has other relations to all the great interests of our confederacy, political, commercial, and social, the prosperity of which essentially contributes to the common defence. Of these it is not my purpose to treat, further than to point to the additional resources which it would develop, and the increase of population which must attend upon giving such facility of communication to a country so tempting to enterprise, much of which having most valuable products, is beyond reach of market.

REPORT
OF
CAPTAIN A. A. HUMPHREYS, TOP. ENGINEERS,
UPON THE
PROGRESS OF THE PACIFIC RAILROAD EXPLORATIONS AND SURVEYS.

WAR DEPARTMENT,
Office Pacific Railroad Explorations and Surveys,
Washington, November 29, 1855.

SIR: Since my report to you of February 5; 1855, the general map of the territories of the United States lying between the Mississippi river and the Pacific ocean has been completed as far as the materials collected admit, and is in the hands of the engraver. The labors of the parties organized for continuing explorations will afford data for still further additions.

Many of the maps, drawings, and scientific papers intended to form part of the reports submitted to you by the first exploring parties, soon after their return from the field, could only be prepared after an elaborate use of the materials collected. In some instances hastily prepared drawings and preliminary reports were temporarily substituted for the more elaborate results, which are now, for the most part, complete.

The results of the investigations in the various branches of physical science in connexion with the expeditions are of great practical value, and full of scientific interest. The geological and meteorological reports are eminently so in many points of view. By the former it will be perceived that the sources and quality of building materials at various remote and important localities have been determined, and rich deposits of gypsum and limestone have been marked out. On the routes of the 35th and the 32d parallel, the structure of desert areas has been minutely studied with special reference to the practicability of obtaining water by wells or by boring, and generally with the most satisfactory results. From the report of Mr. W. P. Blake, the geologist of the expedition in charge of Lieutenant R. S. Williamson, it appears that the structure of the Colorado desert, between Fort Yuma and the Coast mountains is very favorable to the success of artesian borings, and it is considered probable that an abundant supply of water would be obtained by boring to a moderate depth. Such a result would be of extreme importance, not only by facilitating communication between Fort Yuma and the coast for government trains, but as a relief to the emigrant parties which are constantly crossing to California through New Mexico and Sonora. The general nature and composition of the soils and sub-soils over the region explored has been determined, and analyses of the most desirable have been made. An analysis of the soil of the alluvial portion of the Colorado desert, which

covers an area of 4,500 square miles, and is four times greater in extent than the land under cultivation on the Mississippi river, between the mouth of Red river and the Balize, shows that it has all the elements of great fertility, and, but for the adverse climatic conditions, would rival in its productions the best lands of the Delta of the Mississippi. According to the barometrical levellings of Lieutenant Williamson, the alluvial portion of this plain is lower than the surface of the Colorado river; and should this be confirmed by more accurate modes of levelling, as there is every reason to believe it would be, an extensive system of irrigation would entirely change the character of its surface by the introduction of water, the only element required for great productiveness. About one half of the Colorado desert is within our territory.

Valuable ores of several metals have been brought in and examined, and their localities visited and described. A specimen from the collection of Captain Pope proves to be a mass of carbonate of lead, nearly pure, and containing seventy-two per cent. of metal. Another specimen of earth, from the bed of Delaware creek, contains over eighteen per cent. of free sulphur. In California two veins of copper ore, one of iron, and one of antimony, of great extent and richness, have been found and reported upon; worth alone the whole cost of Lieutenant Williamson's expedition. The character and extent of large deposits of bitumen asphalt near Los Angeles has also been made known. The examination of a collection of salty and alkaline incrustations from the soil and dry lakes of California, shows that they consist principally of salt, sulphate of magnesia, and carbonate of soda. Nitre was not found in any quantity.

Along the 35th parallel the carboniferous limestone has been found as far west as the San Francisco mountain, in longitude 112°. The discovery of these rocks so far west renders it possible that deposits of true coal will be found in that region, although, the observations having been very limited, none has yet been seen. The probable existence of coal in other new and important localities has been indicated, which more thorough examinations may develop. Much additional geological exploration is required to throw light on this important subject.

The character of the sand-hills of the Colorado desert has been carefully considered by Mr. Blake, who has shown that they are confined in position to a bank or terrace, and, contrary to the opinion previously entertained, do not constitute a formidable obstacle to the construction and working of a railroad.

Among the results of special scientific interest is the determination of the geological age of mountain chains. It has been ascertained that the coast mountains, in the vicinity of San Francisco, and further south, have upraised within or since the Eocene division of the Tertiary period. The strata about San Francisco, Benicia, Monterey, and other localities, have been shown to be of Tertiary age, and the foldings and contortions to which they have been subjected reveal the violent disturbances and mighty changes of that part of the continent within recent geological times. Tertiary marine shells and sharks' teeth have been brought from the tops of hills, at the base of the Sierra Nevada, over 1,500 feet above the ocean.

Of similar interest are the examination and description of volcanoes, the exhibition of the nature of the rocks and soils along the several routes, by large collections of rocks, minerals, and fossils, and the comparison of the ages of mountains, and the strata on their flanks. These additions to our knowledge of the geological structure of the country have been of great assistance in determining its general features and topography.

The results of the investigations into the zoology and botany of the country west of the Mississippi have proved interesting and important. The existence and geographical distribution of many species, useful in an economical point of view, or interesting to science, have been determined.

The precise range of the buffalo, the antelope, the prairie dog, the various species of deer, and of other animals, with that of numerous valuable trees and herbaceous plants, has been satisfactorily ascertained. Several forms of animal and vegetable life, noticed by earlier travellers, especially by Lewis and Clark, but unknown since their time, have been re-discovered.

The labors of the naturalists and the collectors attached to the several parties have resulted in a collection illustrating the natural resources of our country west of the Mississippi, more complete than will be found in all the museums of the United States and Europe combined.

Lieutenant Williamson's report shows a remarkable coincidence of the elevations deduced from barometrical observations with those obtained at the same time by the spirit-level. The profiles of the Tejon Pass and the Cañada de las Uvas, delineated from the spirit-level altitudes, differ so slightly from the barometrical profiles, that the barometer may be regarded as sufficiently accurate for the purposes of railroad reconnaissance in that climate.

The report of Captain Whipple, topographical engineers, upon the manner in which the elevations for the elaborated profile of his route have been deduced, indicates means by which great accuracy can be obtained in barometrical levelling over extensive regions, without the delay consequent upon the mode of eliminating those errors arising from irregular changes of atmospheric pressure, by simultaneous observations at near points. Between the Mississippi and the Pacific, these errors are in some instances equal to 1,000 feet. The investigation made by Captain Whipple leads to the following conclusions, regarding these irregular movements of the barometer :

1st. They are of great magnitude, and if not taken into account may produce an error in the deduced altitude of many hundreds of feet.

2d. They are but slightly affected by local storms.

3d. They may occur almost simultaneously over the whole interior portion of the continent.

4th. They are actually identical within certain areas of great extent.

These conclusions will be regarded with great interest by scientific explorers and those engaged in studying and observing meteorological phenomena.

It has been suggested, in connexion with this, to make series of barometrical observations at military posts on lines crossing our terri-

ories from east to west, in order to determine the areas over which these irregular (abnormal) movements occur simultaneously. These having been ascertained, it will be merely necessary, in future explorations, to have corresponding observations made at one point in each of the barometrical areas, or regions, traversed by an expedition. The plan of observations proposed could be carried into effect at the cost of a few thousand dollars; and, incidentally, would make important additions to meteorological knowledge.

As a kindred subject, I beg leave to ask your attention to a proposed arrangement for improving the means of computing the observations for longitude of exploring parties. The best mode of determining longitudes by these parties, is that of observations upon moon culminating stars. One night's observations by a good observer will give a resulting longitude—the error of which will not exceed two miles, provided there are corresponding observations at some well determined point; but without these corresponding observations, errors, three or four times as great, may be introduced by the use of tables of the computed positions of the moon. Thus it appears that the field observations are more accurate than the means of computing used in the office. This source of error could be obviated by a preconcerted arrangement with an observatory for observations, at certain times during the continuance of exploring parties in the field.

Upon reviewing his barometrical work for the correction of errors due to abnormal changes, Captain Whipple has included a mass of altitude observations, not reduced before for want of time, which gives a remarkably detailed and accurate profile of the ground; and in connexion with the equally minute topographical notes, now for the first time used, has greatly improved the character of his route as a railroad line.

Among the most important changes that the revision has introduced, may be mentioned the reduction of the length of the route, which from Fort Smith to San Pedro is now 1,760 miles, and from Fort Smith to San Francisco, direct from the Mojave river by the Tay-ee-chay-pah Pass, avoiding the tunnel of the Cajon Pass, it is 2,025 miles. In the preliminary report the distances were measured upon the wagon trail; those now given are along the plotted railroad line. Many of the difficulties of construction previously reported may now be obviated; and there is strong probability of improving the route still further, by shortening distance and avoiding costly construction. A scrutiny of the barometrical observations through Campbell's Pass of the Sierra Madre, about twenty miles north of the Camino del Obispo, shows that that mountain chain may be crossed without a tunnel or excavation at the summit, with a maximum grade of 40 feet to the mile, at an elevation of 6,952 feet above the sea. By the Camino del Obispo, the old route, elevation 8,250 feet, a tunnel three quarters of a mile long, at an elevation of 8,000 feet, was required.

The elevations of several of the passes have been materially reduced; and the data are now provided for an actual computation of the excavation, embankment, and cost of construction of the proposed route.

As this computation necessarily involves much tedious labor, it has not yet been made, and in the mean time Captain Whipple has submitted an estimate similar to those of the other routes, in order to exhibit more correctly the comparative practicability of this, than was done in the preliminary report. It is based upon the facts developed by a careful study of the observations made, and the material collected in the field, and it is believed by him that the amount will be much diminished when the results of the computation are arrived at. The cost of construction, as given in the preliminary report, was greatly exaggerated, the estimates having been formed without reference to the field-notes. In the examination which, by your direction, I made of that report, the estimates were thought by me to be largely in excess. They were—

From Fort Smith to San Pedro, distance 1,892 miles,	\$169,210,265 00
From Fort Smith to San Francisco, the road leaving the Mojave river 34 miles from the east entrance of Cajon Pass, and crossing the Tay-ee-chay-pah Pass, (the estimate from the Mojave river to San Francisco, a distance of 406 miles, having been made by me) distance 2,174 miles.....	175,877,265 00

These would now become—

From Fort Smith to San Pedro, distance 1,760 miles,	86,130,000 00
From Fort Smith to San Francisco, crossing direct from the Mojave river to the Tay-ee-chay-pah Pass, distance 2,025 miles.....	94,720,000 00

Under the appropriation for continuing explorations and surveys to ascertain the most practicable and economical route for a railroad from the Mississippi river to the Pacific ocean, three parties were organized by your directions.

The first, under the command of Lieutenant John G. Parke, topographical engineers, was instructed by the letter of the department of October 2, 1854, to determine the practicability of constructing a railroad from the waters of the Bay of San Francisco to the plain of Los Angeles, by the Salinas River valley, and through the spurs of the Coast range, which extend to the seacoast near Point Conception, or, if that was found to be impracticable, by the coast route; to make certain explorations in the Great Basin, in connexion with the route of the 35th parallel, and between the Pimas villages on the Gila and the Rio Grande; the attention of the party being particularly directed to such examinations in the latter region as would show the degree of practicability of constructing artesian and common wells. These duties have been thoroughly and satisfactorily executed, and the party has just returned to Washington from the field. A rough reduction of portions of the field-work, at the most difficult points, shows that a railroad route from the headwaters of the Salinas, through the spurs of the Coast range, direct to the plains of Los Angeles, is not practicable; whilst that along the coast route is eminently so. With equal length,

it has the advantage over the route by New (Williamson's) and Tay-ee-chay-pah Passes, of a less sum of ascents and descents, less elevation, (the greatest attained being only 1,350 feet above the sea,) less cost of construction, and of passing continuously through a settled and cultivated country. The grades are favorable, the greatest required being, with a cut of 60 feet at the summit, 125 feet per mile for the space of 15 miles, (ascending and descending;) and this, it is believed, can be reduced to 100 feet per mile, by a tunnel 1,000 feet long.

The labors of the party will develop the topography of a district that was before unknown, or the nature of which was greatly misconceived; and will show a practicable railroad route, with easy grades, connecting the valley of Salinas river with the head of Tulare valley, by the Estrella, a tributary of the Salinas, and the Estero, a plain lying within the Coast range and connected with the Tulare Valley, near the Cañada de las Uvas. The exploration in the Great Basin was successfully executed, demonstrating that the Mojave river is a stream of the Great Basin, and does not flow into the Colorado at any time; an elevated ridge separating the basins of the two rivers.

The topographical examinations between the Pimas villages on the Gila and Doña Ana, or El Paso, on the Rio Grande, have resulted in many important improvements upon the line of survey of last year. They have established the practicability of constructing a railroad between those points, by the Gila river, to the mouth of the San Pedro, and up that stream to the vicinity of the line of 1854; a route possessing great advantages over all others in this region, since, from the Pimas villages to the point of departure from the San Pedro, a distance of 166 miles, it passes along the cultivable valleys of those streams, instead of over bare jornadas. The ridge of mountains east of the San Pedro is crossed by a more direct route than that of the old line, and the Puerto del Dado of the Chiricahui mountains is avoided, that range being turned on the north by a gap or break lying between it and Mount Graham. The length and the cost of construction of this route will be about the same as of that examined by Lieutenant Parke in 1854; the summits to be overcome will be fewer in number, the elevations less, the grades more gentle, and the supply of water greater: these, with the great advantage first mentioned, constitute this the best route yet made known in that region. The results of the examinations with reference to the supplies of water make it probable, from the form and geological structure of the basins and plains, that ordinary wells, at distances not exceeding twenty miles, would furnish abundant supplies, distances not too great for the economical working of passenger trains. They also indicate the feasibility of artesian wells in some localities, which might be resorted to if needed.

Upon the arrival of Lieutenant Parke at Fort Fillmore, after the completion of this duty, a report was made by him to this office of the principal results bearing upon the question of supply of water, of the points where it was desirable to have borings made, indicated in the order most suitable for trial, together with all the information necessary for the party directed to make the borings. A copy of this was furnished by Lieutenant Parke to Captain Pope, then engaged in the

construction of an artesian well near the Pecos, who had been previously instructed to make the requisite borings west of the Rio Grande, upon the successful completion of the first duty assigned him.

By the construction, at no great cost, of a series of eight common wells between the Rio Grande and the San Pedro, and a series of four or six across the plain known as the Colorado Desert, and the expenditure of a few thousand dollars in making the route along the San Pedro and the Gila, to the Pimas villages, practicable for wagons, an excellent emigrant and mail route for coaches will be had, and great suffering be saved to those crossing the continent in this latitude. This route will be much shortened, and its value still further increased by constructing a series of artesian wells, not exceeding five in number, across the Llano Estacado. The party of Lieutenant Parke is now engaged in the reduction of the field-work and preparation of the reports, maps, &c.

The duty assigned to the second party organized under the direction of Brevet Captain John Pope, topographical engineers, by the instructions of the department of January 5, 1855, was that of testing the practicability of procuring water by artesian wells on the arid plains of the interior.

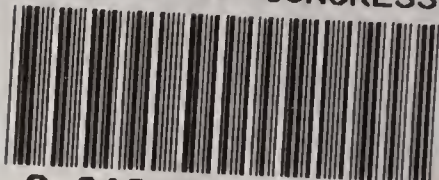
The point selected for the first trial was upon the Llano Estacado, near latitude 32° , about fourteen miles east of the Pecos, at the mouth of Delaware creek, where water for the use of the party could be conveniently obtained from the river. The party arrived at this point in the latter part of May, and commenced the operation of boring. At the depth of three hundred and sixty feet water was reached, which rose immediately seventy feet in the well, and remained at that height—the level of Delaware spring. It was found that the various strata of sandstone passed through in boring did not possess the degree of hardness reported by Mr. Marcou, the geologist, who examined the geological collection made by Captain Pope when crossing the Llano the preceding year; and in consequence, after some delays from the caving in of the sides of the well, it was found necessary to line it with tubing throughout. From the reported character of the formation, five hundred feet of tubing was considered sufficient for all the experiments the party was directed to make, less than half of which would be required for the well of the Llano Estacado; but the unexpected softness of the strata made it necessary to use all the tubing in the first five hundred feet. About the middle of September, at the depth of six hundred and forty feet, a second supply of water, pressed up through sandstone, was attained, which rose three hundred and ninety feet in a few minutes, and was still rapidly rising, when the caving in of the marly clay below the tubing filled in the well to the height of seventy feet, and effectually cut off the communication of the subterranean reservoir or stream with the surface. An attempt was made to remove this accumulation with the mud-pumps, but, after a continuous labor of twelve days and nights without making any impression upon it, the attempt was discontinued, as without additional pipe the well could not be finished; and, in the opinion of Captain Pope, the practicability of constructing artesian wells on the Llano Estacado had been fully estab-

lished. The party then proceeded to the execution of the second duty assigned to it.

This result having been reported to the department, by your directions, measures were taken to supply additional tubing to Captain Pope who has been instructed to resume the work on the Llano.

In the opinion of the officer charged with the operation, they had, at the depth of six hundred and forty feet, closely approached coal measures, and he was convinced that a clear stream or reservoir would have been found twenty feet lower. From his report and accompanying diagram it appears that, at five hundred and seventy feet, a stratum of dark blue shale of the coal measures was pierced. It is highly probable that the water, which appeared at the depth of six hundred and forty feet, pressed up through the lower portion of the stratum of sandstone which they had been boring through for the last sixty feet, would have risen to the surface in large quantities. As the first supply of water rose to within two hundred and ninety feet of the surface, it might reasonably be concluded that, if another supply were attained three hundred feet below the source of the first supply, it would rise to the surface; the bottom of the boring was within twenty feet of this point when the second supply was pressed up through sandstone. The level attained by the first supply of water was that of Delaware spring. At Independence spring, which is west of Delaware spring, and six hundred feet above it, the upper carboniferous formation of the Guadalupe mountains begins. If the strata of sandstones, indurated clays, and marls, found between these two springs, should extend under the Llano Estacado, parallel to each other, and of equal thickness, it was probable that, at a depth of six hundred feet below the point at which the first supply of water was reached, (coming from the same level as Delaware spring,) the second supply would be had coming from the upper carboniferous strata and the level of Independence spring; but as the blue shale of the coal measures was reached at one-half this depth, it would appear that the strata are about three hundred feet apart at the point where the boring was made, instead of six hundred feet, as they are between Delaware and Independence springs. Both supplies of water in the well were clear, pure, and palatable, free from any impurities, appreciable by the tests at the command of the geologist, Dr. Shumard. An important result of this boring is the probable existence of coal in the carboniferous formation which appears upon the surface at the foot of the Guadalupe mountains.

The instructions of the department required Captain Pope, after the successful completion of the well on the Llano Estacado, or the demonstration of its impracticability, to make borings at certain points west of the Rio Grande on the route to be examined by Lieutenant Parke's party, in order to determine the practicability of artesian wells there, and the depths at which water can be had (by ordinary wells) at the dryest season, and the thickness of the water-bearing strata. By the time this duty is completed, it is probable that he will have received the additional tubing necessary to the successful completion of the artesian well on the Llano Estacado, and will then be enabled to resume that work.



The importance of obtaining large supplies of water on the plains and basins, by the construction of artesian wells, at cost, is too apparent to need exposition.

The greater part of the rain and other precipitation in those arid regions falls upon the mountains, and, percolating through the loose debris on their flanks, descends below the surface of the plains, appearing again, sometimes at great distances, in springs and streams—the sources of rivers.

On the plains and table-lands of Asia, which so closely resemble those of North America that a description of one may be taken for the other, water for irrigation, where no streams are found, is obtained by a series of wells connected by subterranean conduits. This laborious process is extensively used, and converts waste barren land into productive fields.

If to a demonstration of the practicability of constructing artesian wells at moderate cost on the interior plains and table-lands be joined the discovery of coal-beds, fertility, industry, and wealth may be made to take the place of sterility and solitude over extensive areas of those arid, naked, and treeless districts.

A third party, under the command of Lieutenant R. S. Williamson, topographical engineers, was organized, under instructions from the department of May 1, 1855, to explore, first, the region between the Sacramento and Columbia rivers, to ascertain the practicability of connecting them by railroad; second, to make examinations and surveys near the sources of Carson river, to ascertain the practicability of crossing the Sierra Nevada in that vicinity by railroad, provided the information obtained from the troops and others who had recently crossed the mountains by that route should indicate the probable existence there of a railroad route. By a report of this officer of the 19th of October, the first duty has been successfully executed.

In addition to the immediate practical value of these explorations in ascertaining the best routes suitable for rail and common roads; their importance from military considerations; their usefulness in making known shorter and better routes of travel to emigrants by which much suffering and loss is avoided; their value in indicating additional sources of national wealth and strength; in substituting exact knowledge for vague surmise and the entirely unknown; the large amount of valuable information collected by them respecting the physical features and condition of our country in topography, geography and geology, meteorology, botany, and zoology, render it highly desirable to continue them.

Many portions of the interior are entirely unknown; and for continuing their exploration during the following year, an appropriation of one hundred and fifty thousand dollars could be well expended.

Very respectfully, your obedient servant,

A. A. HUMPHREYS,
Captain Top. Engineers.

HON. JEFFERSON DAVIS,
Secretary of War.